Remarks

Claims 2-10, and 13-19 are now in the case for examination.

Support for the amendments to the claims can be found on pages 8 and 9 and in the drawings.

Regarding the Examiner's inquiry concerning common ownership of the invention, Applicants submit that the claim of each invention was commonly owned at the time a later invention was made.

The rejection of claim 1-16 under 35 U.S.C. § 103(a) for being unpatentable over Kroneisen et al., U.S. Patent No. 4,410,854, in view of Collings et al., U.S. Patent No. 5,073,753 and Kostiuk et al., U.S. Patent 5,588,825, is respectfully traversed.

The Applicants' invention is directed to a flow-through apparatus and process for the monitoring and control of the combustion process within the burner assembly of a combustion system. The Applicants' apparatus monitors, in real-time, *in-situ*, the combustion of hydrocarbon-based fuels and controls the combustion process by monitoring the level of current conducted through the flame and, in turn, adjusting the fuel and/or oxidizer supplied to the burner. Typically, the burner applicable for use with this invention is part of a gas turbine, however, it may be used with other commercial or industrial burners. Due to the large volumes of hydrocarbon fuels and oxidizers passing through these burners, and likewise, the high linear velocities of the fluids, the burner must have a relatively straight flow path for efficient operation. These burners are typically open at both ends to accommodate the large volume through put of precombustion and postcombustion gases. The Applicants' invention is not directed to an enclosed chamber for combustion of small quantities of sample gases. Further, the Applicants' invention is not directed to the analysis or measurement of the carbon content of an exhaust gas stream.

Kroneisen is directed to an analytical or a sampling device, for measuring the carbon concentration of gas fuel in an exhaust gas mixture. As Kroneisen states, the detector of this type could; "be used for measuring the concentration of carbon in hydrocarbons contained in the exhaust fumes for combustion engines" (Col 1, lines 19-21). Kroneisen asserts that the disclosed detector will provide more stable measuring results. The Kroneisen's flame ionization detector achieves these results by requiring that the elements of the detector have particular,

well-defined dimensions. Further Kroneisen's detector operates within an enclosed chamber of fixed geometry. In particular, Kroneisen is directed to a detector confined to a case 1 having a top and cover parts 2, a basic cylindrical part 3, and a bottom part 4, (Column 2, lines 33-35). This produces a detector, which as Kroneisen notes, is one "which is sufficiently accurate so that carbon equivalent of any and all hydrocarbons in the measuring gas can be detected at an error rate not greater than ± 5% in relation to the absolute content of such hydrocarbon of hydrocarbons within a range of concentration of not greater that 10% methane equivalent," (Column 1, lines 40-44). The detector of Kroneisen accomplishes these objectives by burning the measuring gas in the detector with a fuel, typically hydrogen, and air. The Kroneisen patent specifies low gas flow rates (2-10 milliliters/minute) for the measuring gas and specific nozzle geometries for the detector. Kroneisen does not disclose or suggest the monitoring the combustion of a hydrocarbon fuel within the burner of a combustion system. Further, Kroneisen does not disclose or suggest a flow-through design and instead uses an enclosed chamber. Also, Kroneisen does not disclose an apparatus for the real-time monitoring and control of the combustion process in the combustion zone of a burner.

The Applicants argue that the disclosed device of Kroneisen, an analytical or test device for accurately measuring the carbon equivalent of hydrocarbons in a measuring gas, would not function in the high flow volume environment of a combustion system. The Kroneisen patent describes a standalone sampling unit comprising an enclosed chamber wherein the hydrocarbon sample, or measurement sample, is extracted from a system containing unburned hydrocarbon and supplied to the FID at a limited rate. Kroneisen states measuring gas flow rate of 2-10ml/min and hydrogen flow rates of 42 to 48 ml/min. The example in the Results section of the instant application notes a fuel flow rate of 136 sft^3/hr, which equates to 80ml/min. This is eight to forty times greater than the measuring gas flow rate of Kroneisen and approximately twice the hydrogen fuel rate of Kroneisen. While the differences between the flow velocities of the instant application and Kroneisen are significant, they are more significant between the flow velocities in the industrial burners, for use with the Applicants' invention, and the flow rates of Kroneisen. The flow rate in the example appearing in the Applicants' application is near the lower end of the operating conditions in which the Applicants' invention would function. The device of the Kroneisen patent would not function in the environment of the Applicants' invention. Further, the time delay and gas degradation associated with off-line

sampling would not provide information promptly as is required for good control of the combustion process.

In Kroneisen, the flow of hydrogen, air, and sample gas (which is of certain hydrocarbon concentration) is limited within a select range. In the Kroneisen detector the flow of the gases is limited within a range in order that the hydrocarbon concentration can be accurately determined using the measured current. The disclosure of Kroneisen is opposed to, the instant invention (CCADS) of in-situ monitoring, wherein we claim that one can control the fuel and/or oxidizer using the CCADS measurement (Claim 7, 15, 16 and 19) for any flow rates. In the CCADS the Applicants are establishing a certain current through the flame by adjusting the air, and/or fuel. This claim, for example, allows for combustion systems using adjacent burners as part of a large industrial system such as a gas turbine to basically balance the combustion process in the local combustion zone throughout the system by using this relative signal and adjusting the air, and/or fuel.

Also, in Kroneisen the measurement sample is burned using a hydrogen flame (Column 2, line 37), and does not rely on the measuring sample as a fuel source itself to support combustion, as does the Applicants' invention. Applicants' invention does not require a second source of fuel to burn the mixture since the instant invention is designed to operate at the primary source of combustion, as opposed to determining the composition of the exhaust gases outside of the combustion process as in Kroneisen. The addition of a second fuel source in Kroneisen would add another variable to an already complex control situation. The Applicants' argue that this would not work in the situations in which the Applicants' invention is designed to operate.

Furthermore, the embodiments, disclosed by the Kroneisen patent, call for specific spacing of the electrode and the second electrode location in the combustion zone (col 2, lines 1-5). The Applicants' apparatus does not require the critical dimensions or choice of materials as Applicants' device is designed to be used in the high temperature and high gas flow velocity environment of a combustion burner. Therefore, the Applicants' argue that their invention of claims 2-10, and 13-19, as now claimed, is clearly novel, unobvious, and therefore clearly patentable over Kroneisen.

Collings et al., like Kroneisen is directed to detection of unburnt hydrocarbons in the exhaust gases from an internal combustion engine. Collings, like the Kroneisen reference

utilizes hydrogen or another fuel to combust the hydrocarbons in the sample gas. Further, the detector of Collings operates under control gas flow conditions and apparatus geometries. Collings do not suggest the flow-through design claimed by the Applicants. Collings do not disclose or suggest an apparatus for the monitoring and control of the combustion process in the burner assembly of a combustion system. Further, Collings does not disclose an apparatus having a combustion system comprising a fuel nozzle having an outer shell in fluid communication with the fuel nozzle, a means for supplying a hydrocarbon-based fuel to the fuel nozzle at a rate; a means for supplying an oxidizer to the fuel nozzle at a rate; a means for igniting the hydrocarbon fuel and oxidizer thereby initiating the combustion process, the products of which comprises hydrocarbon ions; a sensor positioned within the combustion system, said sensor including a first electrode and a second electrode in spaced-apart relationship of the first electrode, wherein at least a portion of the combustion process takes place between the first and second electrodes; and a means for measuring the current induced though the combustion zone.

Applicants' apparatus is directed to the *in situ* monitoring and control of the combustion process in the combustion zone of a burner of a combustion system while the combustion process is taking place. The Applicants' invention is not directed to a device for testing the unburnt hydrocarbons external to the primary combustion process as disclosed by Kroneisen and Collings. Clearly, the Applicants' monitoring system is unobvious over Kroneisen and Collings, as these references are directed to the analysis of the off gases of an internal combustion engine. Therefore, the Applicants' argue that their invention of claims 2-10, and 13-19, as now claimed, is clearly novel, unobvious, and therefore clearly patentable over Kroneisen and Collings.

Kostiuk et al. is directed to a lean premix fuel burner. Kostiuk is not directed to an analytical device for measuring unburnt hydrocarbons in the exhaust stream from an internal combustion engine or the like. Kostiuk is not directed to the monitoring and control of the combustion process. Further, there is nothing within the disclosures of Kroneisen and Collings to combine the combustion product monitoring of these references with Kostiuk. Absent the instant application there is no basis within the references for combining the references as suggested by the Examiner. Therefore, the Applicants maintain their position that the

Applicants' apparatus as now claimed, in claims 2-10, and 13-19 is novel and unobvious over Kroneisen in view of Collings and Kostiuk.

The Applicants believe that the application, including claims 2-10, and 13-19 is now in allowable form. Allowance is therefore respectively requested.

Respectfully submitted,

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